IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

U.S. Serial No.:	10/709,065
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Applicant:	Norek, Richard S.
Title:	FORMING GAS TURBINE TRANSITION DUCT BODIES WITHOUT LONGITUDINAL WELDS
Atty. Docket No.:	NOR.US.6
Art Unit:	3726
Examiner:	Jimenez, Marc Quemuel

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF RICHARD S. NOREK
37 CFR § 1.132

I, Richard S. Norek, the applicant in the above-referenced application, hereby declare the following:

1. I have an MSME from Rensselaer Polytechnic Institute. I have a broad engineering experience; 6 yrs in academia, 12.5 years in industry, 18 years in consulting for a large gas turbine user, and 7 years as independent consultant and inventor. My industrial experience has been mainly in the field of gas turbines, specifically hot gas path components made of superalloys. My fields of expertise include stress analysis, creep, fracture mechanics, vibrations, rotor dynamics, hot corrosion and overall material behavior and life extension. During 18 years employment in Aramco and Saudi Aramco (largest oil producing company in the world) I served for 13 years as No.1 turbine expert in the company ultimately responsible for the overall performance of a diversified gas turbine fleet of 214 units, refurbishment of hot gas path components in 20 repair facilities worldwide, and personally responsible for the quality of replacement parts, new and refurbished, in the company stock.

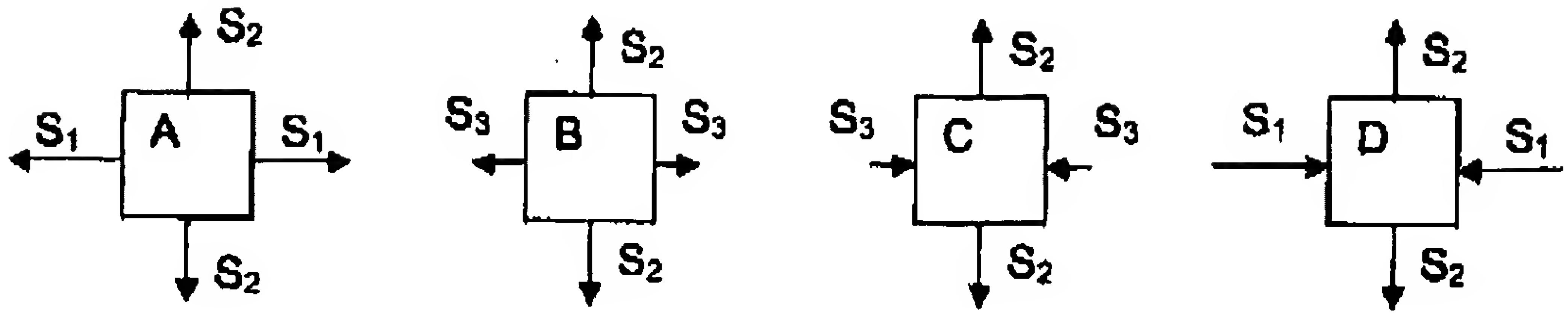
I have 12.5 years of experience with General Electric as a design/development engineer of 14 turbine models, including stationary and rotating mechanical

components. My responsibility included a development of the 2-nd stage nozzle for a 200 MW gas turbine, which was considered the most complicated nozzle in the GE product line at the time. As a design technology unit member, I was responsible for bringing advanced engineering tools to the company design engineering practice. As an independent consultant/inventor, I published/presented two papers and was awarded four US patents. My curriculum vitae is attached (Exhibit A).

2. That one of the differences between my invention and the prior art is the use of bellows. The term bellows is adopted from the expansion bellows installed commonly at the ends of pressurized pipes to allow for sizeable thermal expansion of the pipe ends without producing excessive axial load in the pipes. These bellows are made out of a very high strength sheet metal and appear from the outside like an accordion.

3. That the pipe endings in the present patent application are called "thrust bellows" because, in addition to folds, they are designed to exert a substantial compressive axial force (thrust). The thrust is generated as the folds are straightened under high internal pressure in the pipe, resulting in a sizeable displacement of the pipe ends towards the pipe's center. The thrust produces compressive stresses in the pipe (work piece item 50) over the entire length of the pipe, and the thrust varies circumferentially. The thrust is designed to compress the most those longitudinal fibers of the work piece 50 that experience the most bending in the hydroforming process. The local compressive stresses (axial) in the work piece material in the presence of local tension stresses (tangential) cause both a local yield and a flow of the material that reduce wall thinning.

4. That those skilled in the art know that the local yield in the material depends on the local (specific) energy of shear deformation. Asymmetric stresses in two dimensional stress fields of the work piece wall, where the one dimension is axial and the second is tangential, produce more shear energy (easier yield) than a symmetric stress field. The sketches that follow illustrate the point.



S_1; S_3 – axial stress
S_2 – tangential stress
$|S_3| < |S_1|$

5. That the stress field A is symmetric, in that $|S_1| = |S_2|$. The fields B through D are asymmetric. The stress field D will produce yield at the lowest stress level among A, B, C, and D; that means at the lowest inner pressure in the workpiece. To be more precise, the equivalent, von Mises stress will be the highest for the stress field A and the lowest for the stress field D (von Mises hypothesis is known also as Huber/Mises/Hencky hypothesis based on the names of its authors. Ref. 1).

6. That the bellows thrusters of the present invention actually exert an axial thrust on the ends of the work piece 50 and move them inward, thus do significant supporting work in the forging process.

7. That the thrusters in the present application serial number 10/709,065 (the '065 application) are very distinguishable from the prior art. A short examination of comparisons with the end discs of Schulz and the end caps of Komiya confirms this:

	'065 Application	Schulz	Komiya
1. Name	"bellows thruster"	"end disc"	"bottom member"
2. Form	conventional seal weld of workpiece	conventional seal weld of workpiece	conventional seal weld of workpiece
2a	hemi-spherical (or parabolic) outside envelope of bellows (ridges)	round, flat disc	shallow dish, or hemi-spherical
2b	non-ax symmetric	ax symmetric	ax symmetric

2c	uniform or non-uniform	uniform	uniform
2d	novel pressure vessel (tension tangential stresses; compressive axial stresses varying circumferentially)	conventional pressure vessel	conventional pressure vessel
2e	conventional access to the vessel (valved)	conventional access to the vessel (valved)	conventional access to the vessel (valved)
3. Function	active: bellows thrusters provide variable axial thrust along pipe perimeter	passive	passive
3a	variable axial thrust provided by internal pressure in the workpiece	small axial tension provided by internal pressure (no thrust)	axial thrust provided by the dies
3b	variable yield, tailored to local bending rate	conventional yield	yield less than conventional but not variable.
3c	a degree of wall thinning control, thinning less than conventional	no wall thinning control, thinning conventional	no wall thinning control, constant thinning less than conventional

8. That bellows thrusters provide significant improvements to the state of the art. Neither Schulz nor Komiya use the term "bellows." My use of "bellows" is intentional and is one of the technical differences between my invention and the prior art.

Declarant further states that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false

statements may jeopardize the validity of the application or any patent issued thereon.

Reference 1: *Strength of Materials,* (in Polish), p 205, Jakubowicz, A., Orlos, Z., WNT, Warsaw, 1966.

Date: 11/23/05 Name: Richard S. Norek

Richard S. Norek

EXHIBIT A

Richard S. Norek

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GENERAL ELECTRIC • *Design/Development Engineer* • *13 Years* *Schenectady, NY*

A designer of 14 turbine models with firing temperatures ranging from 1750°F to 2400°F and power from 11,000hp to 200,000hp. Developed expertise in hot gas path components, superalloy metallurgy, hot corrosion protection, high speed impact, fracture mechanics, rigorous failure investigation and life prediction, compressor and turbine aerodynamics, vibrations and rotor dynamics.

- Applied advanced engineering tools to the design engineering practice.
- Corrected expeditiously various teething problems in new gas turbines.
- Provided engineering expertise to manufacturing, product service and service shop engineers supporting over 1,000 gas turbines worldwide.

Achievements:

- Diagnosed second stage nozzle excessive downstream creep deflection.
- Explained a parasitic natural frequency in a second stage bucket.
- Determined the causes and eliminated catastrophic rotor bolt failure.
- Proposed design improvements, and directed a program in the field for installation of a first stage nozzle with 80% greater life than its predecessor.
- Implemented a major design change to introduce aircraft-type insulation encased in stainless steel foil in heavy-duty turbines and alleviated out of roundness of the turbine inner casings.
- Diagnosed and eliminated overheating of the outer combustion casings in recuperative turbines—*increased operating life of recuperators.*

DANISH TECHNICAL UNIV. • *Lecturer* • *2 Years* *Copenhagen, Denmark*

Taught design of internal combustion engines and machine elements. Worked on vibrations with material damping and on design of centrifugal clutches.

Achievement:

- Developed and published a theory of centrifugal clutches with floating links and novel, non-symmetric shoes, capable of either rigid locking or easy slip at full speed.

POLISH ACADEMY OF SCIENCES • *Sr. Research Assistant* • *5 yrs* *Gdansk, Poland*

Fluid Flow Machinery Institute, Dynamics Laboratory, Gdansk, Poland.
Studied Mathematics at Warsaw University, investigated material damping, and submitted a patent disclosure for a test device to measure the decrement of amplitude during torsional vibrations.

PROFESSIONAL ACTIVITY

Member of the American Society of Mechanical Engineers (ASME), International Gas Turbine Institute (IGTI), Committee on Oil and Gass and Applications, Former Vice President of Saudi Arabia Eastern Province Chapter of ASME International, Member (1980-1997) of the Gas Turbine Users Association (GTUA). Presented technical papers at the ASME, GTUA and Electric Power Research Institute (EPRI) meetings. **25 publications.**

Education

Rensselaer Polytechnic Institute, Troy, NY	MSME
Warsaw University, Mathematics Department, Poland	Advanced Studies
Gdansk Polytechnic Institute, Gdansk, Poland	BS, MME

Richard S. Norek

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Mission

To deliver, as the most valuable resource to the gas turbine owner, the immediate benefits of:
-Solving existing problems.
-Preventing evident future failures.
-Utilizing untapped potential for improvements in turbine units and auxiliary systems.
To achieve these benefits by employing modern, effective, multi disciplinary engineering methods proven in the field to significantly reduce ownership cost.

Profile

Accomplished consultant, field researcher, expert failure investigator, senior gas turbine designer. Skilled in correcting both design and field problems of any complexity, and successful in implementing efficient programs for increasing equipment life, reliability and profitability.

Career

Operations

• Internal consultant to: world's largest oil company's Corporate Management, Crude Production on/offshore, Projects and Purchasing, Crude & Liquid Gas Pipelines, Power Generation, Refineries, Gas Processing, and Maintenance Shop.
• External consultant to companies in Kuwait, Oman, Italy and Venezuela.

Manufacture

For the largest manufacturer of gas turbines, provided services of Gas Turbine Design, Development & Manufacturing, Customer Service, Repair & Refurbishment.

Academic

Tech. University, Mech. Dept, Turbomachinery Institute.

Technology - Applies the state of the art, multi-discipline—structural analysis, heat transfer, metallurgy, aerodynamics, etc.—engineering approach to solve design, operation and maintenance problems of gas and steam turbines. *Service is custom tailored to the user's needs and is based on thorough investigation, accurate analysis and practical, expedient and cost-effective problem solving. This approach has transformed many costly, forced turbine outages into reliable, profitable operation.*

Leadership - Provided, as lead turbine expert in Saudi Aramco, technical direction on utilization of turbines to corporate management, all Saudi Aramco departments worldwide, a project company in Italy, and other oil companies in Kuwait, Oman and Venezuela. Directed international technical exchange between in-house organizations and engineering societies. Led field research, life improvement programs, failure investigations and corrective actions. Created and implemented a unique training program with foreign manufacturers for young engineers to develop future turbine specialists.

Experience - Turbine operation and maintenance, design and manufacture, and teaching and research.

SAUDI ARAMCO • *Engineering Specialist* • *18 Years* — *Dhahran, Saudi Arabia*

- Responsible for the overall performance of diversified gas turbine fleet:
  - 214 units, 22 models by 14 factories, *operating in the harsh desert environment.*
  - Equal mix of heavy industrial and light air-derivative.
  - New to 34 years old, *including GE MS5-2 world fleet leader with over 200,000 hours.*
  - Small and large, from 1000hp to 100MW.
- Provided technical direction for 6 different acquisitions of total 57 turbine trains.
- Inspected and verified 20 repair shops worldwide.
- Performed corrective actions and conducted life improvement programs, uprates and modifications in gas and steam turbines.
- Directed field research—*solved severe problems over 10 years old.*
- Established corporate standards for gas turbines and steam turbines.
- Investigated a large variety of failures from small cracks to total turbine losses, *i.e. compressor and turbine blade cracks, bearing failures, wheel creep rupture, wheel spacer failure, full speed surge and axial compressor massive failure, parasitic natural frequencies of rotors within running speed, internal turbine fires, steam turbine shaft fractures, tip shroud fretting failure.*
- Responsible for over 200 steam turbines rated from 500 HP to 32,000 HP.

Major Achievements:

- Directed turbine nozzle life improvement programs, eliminating premature nozzle deterioration, increasing TBOs (time between overhaul) by a factor of 2 to 3 (i.e. for 34 GE units, from 19,500 hours to 63,000 hours)—*resulting in savings to the company of over $5,000,000 per year.*
- During tenure, turbine failure rate was reduced by a factor of 10 (from 3 per year to 1 in 3 years)—*saving over $6,000,000 per year.*
- Specified design modifications (i.e. superalloy wheels instead of high alloy steel, proper turbine blade coatings, redesign and material upgrade of turbine nozzles for 22 new turbines before delivery)—*that resulted in a $7,000,000 savings plus avoidance of substantial production losses by elimination of failures experienced by others.*
- Reduced the refurbishment turnaround time of hot gas path parts from 6 months to 6 weeks—*reduced inventory of these parts by two thirds.*